UNIVERSITI PUTRA MALAYSIA

POTENTIAL OF SELECTED ENTOMOPATHOGENIC HYPHOMYCETES FOR CONTROLLING THE RICE PESTS, SITOPHILUS ORYZAE (COLEOPTERA: CURCULIONIDAE) AND CORCYRA CEPHALONICA (LEPIDOPTERA: PYRALIDAE)

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FP 2003 29

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By

HENDRAWAN SAMODRA

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

November 2003

DEDICATION

For my parents Hendro Suyoko, my wife Takako, my daughter Aisha and my brother Danis

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Master of Science

POTENTIAL OF SELECTED ENTOMOPATHOGENIC HYPHOMYCETES FOR CONTROLLING THE RICE PESTS, *SITOPHILUS ORYZAE* (COLEOPTERA : CURCULIONIDAE) AND *CORCYRA CEPHALONICA* (LEPIDOPTERA : PYRALIDAE)

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Hendrawan Samodra

November 2003

Chairman : Professor Yusof Bin Ibrahim, Ph.D

Faculty : Agriculture

The rice weevil, *Sitophilus oryzae* (L.) and the rice moth, *Corcyra cephalonica* Stn. are serious stored grain pests worldwide. They attack a wide variety of stored products and are the two important pests of stored rice.

The use of entomopathogenic fungi (EF) is a novel approach to the control of insect pests of stored grains. The potential of dry conidia of three genera of EF, *Beauveria bassiana*, *Metarhizium anisopliae* and *Paecilomyces fumosoroseus* was examined in the laboratory against the adults of *S. oryzae* and the larvae of *C. cephalonica*.

The pathogenicities of nine selected isolates of the EF (BbGc, BbPs, BbPc, MaOrMaj, MaSc, MaGmC, MaOrMan, MaPs, PfPp) to *S. oryzae* adults and

C. cephalonica larvae were evaluated in the laboratory. All the isolates tested were pathogenic against *S. oryzae* adults and *C. cephalonica* larvae but pathogenicity varied among the isolates. Two isolates of *B. bassiana* (BbGc and BbPs) and one isolate of *M. anisopliae* (MaPs) were superior and caused high mortality against both these insects compared to other isolates. The median effective concentration (EC_{50}) for isolates BbGc, BbPs and MaPs against *C. cephalonica* larvae were 1.238 x 10^6, 2.072 x 10^6, 1.775 x 10^6 conidia g^{-1} respectively. However, higher EC_{50} values for these isolates were recorded against *S. oryzae* adult, namely 9.491 x 10^6, 1.377 x 10^7, 1.120 x 10^7 conidia g^{-1} respectively. Thus, it can be concluded that *C. cephalonica* larvae were more susceptible than *S. oryzae* adults to the three selected fungal isolates. The median lethal time (LT_{50}) at concentration 1 x 10^9 for these isolates against *C. cephalonica* larvae were 3.5 d for BbGc, 3.6 d for BbPs and 3.5 d for MaPs and against *S. oryzae* adults were 3.1d for BbGc, 3.3 d for BbPs and 2.5 d for MaPs.

The effectiveness of the EF, *B. bassiana* (BbGc; BbPs) and *M. anisopliae* (MaPs) as mycoinsecticide dusts against *S. oryzae* adults and *C. cephalonica* larvae were evaluated. Each admixture of the isolates with either kaolin, talc or tapioca flour (20% w/w a.i.) as the carriers was thoroughly mixed with long grain rice in a plastic cup (8 cm diameter x 5 cm) at the rate of 0.05 g a.i., 0.1 g a.i. and 0.15 g a.i. in 50 g rice grains. All dosages of these EF isolates in all dust formulations gave 100 % mortality to *C. cephalonica* larvae 12 days after introduction (DAI). At the dosage of 0.05 g a.i. *M. anisopliae* (MaPs) formulated in tapioca flour provided only 82.5% mortality to *S. oryzae* adult recorded within 15 days and this differed significantly from the dosage of 0.10 g a.i. or 0.15 g a.i. In general, the mycoinsecticides in kaolin and talc were more efficacious and faster knock out effect to both insects compared to that in tapioca flour or unformulated control. The 0.1 g a.i. of isolate BbGc in kaolin was significantly the best effecting 100% mortality seven DAI against *C. cephalonica* larvae, while it gave 98.75% mortality against *S. oryzae* adults.

Isolate BbGc in kaolin and talc administered at 0.4 g a.i. in 200 g rice packed in plastic kept at room temperature provided protection in excess of 90% mortality at 15 DAI against *C. cephalonica* larvae up to four months of storage. A lower mortality ranging between 65-78% was recorded on adults of *S. oryzae*. Formulations of MaPs seemed to be effective against both insects only within the first month of storage beyond which infectivity rapidly declined.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan ijazah Master Sains

POTENSI ENTOMOPATOGEN HYPHOMYCETES TERPILIH UNTUK PENGAWALAN PEROSAK BERAS, *SITOPHILUS ORYZAE* (COLEOPTERA : CURCULIONIDAE) DAN *CORCYRA CEPHALONICA* (LEPIDOPTERA : PYRALIDAE)

Oleh

Hendrawan Samodra

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Pengerusi : **Profesor Dr. Yusof Bin Ibrahim**

Fakulti : **Pertanian**

Kutu beras, *Sitophilus oryzae* (L.) dan rama-rama beras, *Corcyra cephalonica* Stn. adalah perosak-perosak serius biji-bijian dalam simpanan di dunia. Perosak- perosak ini menyerang berbagai produk simpanan dan merupakan perosak penting pada simpanan beras.

Penggunaan kulat entomopatogen (EF) adalah sesuatu pendekatan baru untuk pengawalan serangga perosak pada biji-bijian dalam simpanan. Potensi konidia kering tiga genera EF, *Beauveria bassiana*, *Metarhizium anisopliae* dan *Paecilomyces fumosoroseus* telah dikaji di dalam makmal terhadap kumbang *S. oryzae* dan larva *C. cephalonica*.

Patogenisiti sembilan pencilan EF terpilih (BbGc, BbPs, BbPc, MaOrMaj,

MaSc, MaGmC, MaOrMan, MaPs, PfPp) terhadap kumbang *S. oryzae* dan larva *C. cephalonica* telah dinilai di dalam makmal. Kesemua pencilan telah didapati patogenik terhadap kumbang *S. oryzae* dan larva *C. cephalonica* tetapi patogenisiti di antara pencilan didapati berbeza. Dua pencilan *B. bassiana* (BbGc and BbPs) dan satu pencilan *M. anisopliae* (MaPs) didapati superior dan mengakibatkan kematian yang tinggi terhadap kedua-dua serangga tersebut berbanding pencilan yang lain. Median kepekatan berkesan (EC_{50}) untuk pencilan BbGc, BbPs and MaPs terhadap larva *C. cephalonica* masing-masing adalah 1.238×10^6, 2.072×10^6, 1.775×10^6 konidia g^{-1}. Bagaimanapun, nilai EC_{50} yang lebih tinggi bagi pencilan-pencilan tersebut telah direkodkan terhadap kumbang *S. oryzae*, masing-masing adalah 9.491×10^6, 1.377×10^7, 1.120×10^7 konidia g^{-1}. Oleh itu, boleh dirumuskan bahawa larva *C. cephalonica* adalah lebih rentan dari pada kumbang *S. oryzae* kepada ketiga-tiga pencilan itu. Median masa maut (LT_{50}) pada kepekatan 1×10^9 bagi pencilan-pencilan tersebut terhadap larva *C. cephalonica* ialah 3.5 d bagi BbGc, 3.6 d bagi BbPs dan 3.5 d bagi MaPs dan terhadap kumbang *S. oryzae* ialah 3.1 d bagi BbGc, 3.3 d bagi BbPs dan 2.5 d bagi MaPs.

Keberkesanan EF, *B. bassiana* (BbGc; BbPs) dan *M. anisopliae* (MaPs) sebagai mikoinsektisid debu terhadap kumbang *S. oryzae* dan larva *C. cephalonica* telah dinilai. Pencampuran setiap pencilan EF dengan kaolin, talkum atau tepung ubi kayu (20 % b/b b.a.) sebagai bahan pembawa telah digaul serata dengan beras panjang di dalam bekas plastik (8 cm diameter x 5 cm) pada kadar 0.05 g b.a., 0.1 g b.a. dan 0.15 g b.a. dalam 50 g biji beras. Kesemua dos pencilan EF ini di dalam semua formulasi debu menghasilkan 100% kematian terhadap larva *C. cephalonica* 12 hari selepas diperlakukan (DAI). Pada dos 0.05 g b.a. *M. anisopliae* (isolate : MaPs) yang diformulasikan dalam tepung ubi kayu hanya menghasilkan 82.5% kematian terhadap kumbang *S. oryzae* setelah direkodkan selama 15 hari dan ini nyata berbeza dari pada dos 0.10 b.a. atau 0.15 b.a. Pada amnya, efikasi mikoinsektisid dalam kaolin dan talkum adalah lebih cepat memberi kesan rebah ke atas kedua serangga berkenaan berbanding didalam formulasi tepung ubi kayu atau kawalan tidak terformulasi. Pada dos 0.1 g b.a. pencilan BbGc dalam kaolin nyata paling baik memberikan 100% kematian terhadap larva *C. cephalonica* tujuh DAI, sedangkan ia hanya menghasilkan 98.75% kematian terhadap kumbang *S. oryzae.*

Pencilan BbGc dalam kaolin dan talkum yang dimasukkan pada dos 0.4 g b.a. ke dalam 200 g beras yang dimuatkan di dalam plastik pada suhu bilik memberikan perlindungan melebihi 90% kematian pada 15 DAI terhadap larva *C. cephalonica* sehingga empat bulan simpanan. Kematian lebih rendah antara 65-78% direkodkan terhadap kumbang *S. oryzae*. Formulasi debu MaPs agak berkesan terhadap kedua serangga tersebut hanya dalam bulan pertama penyimpanan selepas mana kejangkitannya menurun dengan cepat.

ACKNOWLEDGEMENTS

Above all, I would like to thank Allah S.W.T., Most Gracious, Most Merciful, for his Compassion and Mercy.

I would like to express my deep sense of gratitude and appreciation to my supervisor, Professor Dr. Yusof Ibrahim, for his advice, guidance and constructive criticisms in connection with the research and preparation and revisions of this manuscript. I also would like to extend my thank to my other committee members: Professor Dr. Dzolkhifli Omar and Puan Noorma Osman.

I gratefully acknowledge Integrated Pest Management of Smallholder Estate Crops Project – Plant Quarantine Component in Agricultural Quarantine Agency, Ministry of Agriculture in Indonesia for providing me the financial support which enables me to pursue this degree.

A special note of thanks goes to my friends, colleagues, and staff members of Department of Plant Protection, Faculty of Agriculture, UPM.

I would like to express my deepest thanks and appreciation to my father, Hendro Suyoko who passed away five years ago. Also my mother, Wiryani for encouragement, support and endless prayers during my study in Malaysia. This endeavour would not have been feasible without the sacrifice, patience, understanding and encouragement of my dearest wife Takako.

I certify that an Examination Committee met on November 10, 2003 to conduct the final examination of Hendrawan Samodra on his Master of Science thesis entitled "Potential of Selected Entomopathogenic Hyphomycetes for Controlling *Sitophilus oryzae* (Coleoptera: Curculionidae) and *Corcyra cephalonica* (Lepidoptera: Pyralidae)" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirements for the degree of Master of Science. The members of the Supervisory Committee are as follows :

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Date : 12 MAR 2004

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

HENDRAWAN SAMODRA

Date : 23-2-2004

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CHAPTER I

INTRODUCTION

Stored product pests are still one of the causes of qualitative and quantitative losses of food crops during storage. Quantitative damage is due to grain weight loss caused by insect feeding. Qualitative damage is due to product alterations such as loss of nutritional and aesthetic value, increased levels of rejects in the grain mass and loss of industrial (baking) characteristics. They are also important pests of stored seeds by damaging the seed embryos and causing a decrease in germination (Pranata *et al.*, 1988; Baier and Webster, 1992; Thuy *et al.*, 1994; Moino *et al.*, 1998).

The rice weevil, *Sitophilus oryzae* (L), is one of the most serious stored grain pests worldwide. This pest of whole grain originated in India and has spread worldwide by commerce. It is now a cosmopolitan pest. *Sitophilus oryzae*, an ubiquitous pest of economic importance, is an internal feeding insect that bores into stored grain. Adult weevils feed mainly on the endosperm, reducing the carbohydrate content while the larvae feed preferentially on the germ of the grain, thus removing a large percentage of the protein and vitamins (Belloa *et al.*, 2000).

The rice moth, *Corcyra cephalonica* (Stainton) is believed to be of eastern origin but it is now a cosmopolitan pest. It has spread throughout the world with the transport of food stuffs. Beside rice, the rice moth is also a major pest of stored grains of pearl millet and sorghum. It becomes established more readily in stored seeds that have been damaged. For this reason the species is regarded as a secondary pest (Hodges,1979). The broken seeds have always been found to provide a more suitable medium than either whole seeds or flours. However, the favourability of whole seeds in comparison with flours depends upon the commodity under consideration. Its development in rice is both more rapid and more successful with whole grain than with the flour.

The control of arthropod pests on stored products has been primarily through the use of fumigants and residual insecticides to augment the more obvious approach of hygiene (Brooker *et al.*, 1992; Adane *et al.*, 1996). The excessive use of conventional insecticides has resulted in a number of serious problems, such as resistant to the chemical insecticides, elimination of economically beneficial insects, persistence in the environment, toxicity to humans and wildlife and higher cost of crop production (Khan and Selman, 1989).

Synthetic chemical pesticides have been the main stay of insect pest control for the past 50 years. The advent of insecticide resistance, pest resurgence and concern over the environmental impact of agricultural inputs are increasingly focusing attention on biologically based form of pest control (Esser and Lemket, 1997). Resistance to chlorpyrifos-methyl has been documented for a number of strains of the lesser grain borer, *R. dominica* in